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LEAFHOPPERS AND PLANTHOPPERS INFESTING COASTAL BERMUDAGRASS: THEIR EFFECT ON YIELD AND QUALITY; THEIR CONTROL BY VARYING FREQUENCY OF HARVEST.

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LEAFHOPPERS AND PLANTHOPPERS INFESTING COASTAL BERMUDAGRASS: THEIR EFFECT ON YIELD AND QUALITY; THEIR CONTROL BY VARYING FREQUENCY OF HARVEST

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ABSTRACT

The effect of leafhopper-planthopper populations on yield and quality of Coastal bermudagrass was studied over a three year period by comparing the yield and quality of grass from insecticide treated and untreated plots. Five harvesting schedules were also included in the experimental design to determine the effect of harvesting frequency of the grass on leafhopper-planthopper populations.

Leafhopper-planthopper control with insecticides resulted in an overall average increase in yield of 16.9% or .96 tons of dry forage per acre. However, yield increases among harvesting treatments varied from 3.6% in grass that was harvested most often (simulated close grazing) to 49.3% in grass that was harvested least often (cut once yearly). Generally as harvesting frequency decreased, leafhopper-planthopper populations increased and yield losses attributable to these insects increased. Inversely, as harvesting frequency increased, the leafhopper-planthopper populations decreased and the reduction in yield due these insects decreased. Therefore, harvesting frequency is an effective means of population suppression of these pests that could serve as one component in a pest management program for their control. Leafhopper-planthopper populations had no significant effect on any of the parameters measured for in vitro quality determination, except for cellulose, which was significantly higher in grass from insecticide treated plots. These data indicate that the detrimental effect of leafhoppers-planthoppers on Coastal bermudagrass is reflected primarily in yield reduction rather that in reduced grass quality.

Leafhoppers[1] and planthoppers[2] infesting Coastal bermudagrass: their effect on yield and quality; their control by varying frequency of harvest

INTRODUCTION: The increasing demand for grain as human food coupled with its increasing cost and decreasing availability for livestock feed has resulted in a greater awareness of those in the cattle industry of the importance of high quality, high yielding forages. This increasing interest in forages has focused attention on (1) the fact that little is known about the effect of insects on yield and quality of pasture grasses and (2) that little is known about non-insecticidal measures for controlling pasture insects. The present study was initiated to determine for Coastal bermudagrass: (1) the effect of leafhopper-planthopper infestations on yield and quality and (2) the effect of various harvesting schedules on leafhopper-planthopper populations.

LITERATURE REVIEW: Osborn (1912), after concluding a long-term study, estimated that leafhoppers reduced hay and grazing yields 25-50%. Wolcott (1937), after studying two pastures in New York, calculated that insects consumed more forage than did cattle grazing the same pastures. Kelsheimer et al. (1953) found that leafhoppers, when present in large numbers, reduced the grazing value of improved pastures in Florida. Kerr (1957) stated that "it is recognized that leafhoppers are of economic importance because of depredation to crops themselves and transmission of plant diseases." Smith et al. (1959) found that the

[1]Homoptera:Cicadellidae
[2]Homoptera:Delphacidae

potato leafhopper, Empoasca fabae (Harris) reduced alfalfa yields as much as 48%. Pounds per acre of protein, ash, calcium, and phosphorus were also reduced as much as 55%. Byers (1967) noted that the application of insecticides significantly increased the yield of Coastal bermudagrass in Georgia. The primary insect pests present were leafhoppers and the fall armyworm, Spodoptera frugiperda (J. E. Smith).

Searls (1934), after studying the effect of cutting schedules upon the occurrence of the potato leafhopper Empoasca fabae (Harris) and alfalfa yellows in Wisconsin, reported that alfalfa cuttings may be synchronized with the life cycles of the leafhopper so as to suppress leafhopper infestations by destroying a large percentage of the egg and/or nymphal stages, thus reducing the damage done by this insect. He stated that the use of properly synchronized cutting schedules was sufficient to produce a satisfactory growth of alfalfa in the absence of all other leafhopper control measures. Graber and Sprague (1935) supported Searls findings. They found that early cutting of first growth alfalfa enabled abundant egg deposition by the remaining adult leafhoppers in the succeeding regrowth resulting in large populations of nymphs which caused significant damage to the second growth alfalfa. Deferred cutting of the first growth, however, allowed a more complete deposition of eggs which were destroyed or removed during the harvesting procedure. Pienkowski and Medler (1962), however, found that a uniform seasonal trend for the potato leafhopper could not be established in a five year study in southern Wisconsin. Therefore, no cutting treatment could be established that would result in the absence of leafhopper damage to alfalfa in any given year.

Smith (1940) in a study of the effect of overgrazing and erosion on the biota of the mixed grass prairie of Oklahoma, noted that a marked increase in the number of leafhoppers occurred when the prairie was overgrazed. The number of species present also increased when erosion accompanied overgrazing, although the number of specimens showed a marked decline. Morris (1971), however, in a study of the differences between the invertebrate faunas of grazed and ungrazed chalk grasslands in Great Britain, reported that a greater number of species and individuals was present on ungrazed grassland. Morris (1973) in a study of the effect of seasonal grazing on the biota of chalk grasslands, found that the abundance of Auchenorhyncha was greater with autumn and winter grazing than with spring and summer grazing.

METHODS AND MATERIALS: Study was initiated at the Macon Ridge Experiment Station at Winnsboro in an established 2 acre stand of Coastal bermudagrass in May 1973. Test plots were fertilized according to soil analysis with one ton of dolomitic lime and 100 pounds of actual nitrogen, P_2O_5, and K_2O per acre on May 17. Additional nitrogen was applied as ammonium nitrate at a rate of 100 pounds N/A on July 9.

In July 1973, a 3 acre field of Coastal bermudagrass was established as a test site at the Idlewild Experiment Station at Clinton using clipped grass for sprigs (Monroe 1958).

In April 1974, Coastal bermudagrass plots at the Macon Ridge and Idlewild Experiment Stations were fertilized according to soil test with 100 pounds actual nitrogen, P_2O_5, and K_2O per acre. Two additional applications of nitrogen were applied as ammonium nitrate at a rate of 100 pounds actual N/A in June and August.

In 1976 test plots were established at Bossier City in established Coastal bermudagrass and again at Clinton. Fertilizer was applied at each site according to soil test.

A split-plot randomized block design was utilized in all tests. Two insecticide treatments, (1) insecticide treated and (2) untreated, served as main plot treatments for obtaining insect-infested and insect-free areas for use in determining the effect of leafhopper-planthopper infestations on grass yield and quality. Different harvesting regimes served as subplot treatments for studying the effect of harvesting frequency on leafhopper-planthopper populations. Main plot treatments were 13,780 ft^2 in size and were replicated 8 times. Subplot treatments were 2,756 ft^2 in size and were replicated 16 times. Furadan™ 4F (4 lbs/gal) was applied at 1/2 lb AI per acre on the insecticide-treated plots. Insecticide was applied with a tractor mounted boom-type sprayer, generally once a week during moderate to heavy insect infestations and on alternate weeks during periods of low infestations. Subplot treatments consisted of five harvesting regimes, which were randomly arranged within each main plot. Harvesting treatments were:

(1) simulated close grazing (cut 7-9 times/growing season)

(2) cutting at 6 inches (cut 4-6 times/growing season)

(3) cutting 3 times/growing season

(4) cutting 2 times/growing season

(5) cutting once at the end of the growing season

In 1973 and 1974 plots were harvested with a Gehl flail chopper. The grass within a 100 ft^2 area was cut from near the center of each subplot at each harvest. The grass from this area was weighed (green weight) to the nearest 0.1 lb for yield determination. The remainder of the grass on the plot was then removed and discarded. A 2 lb sample of grass was taken from each yield sample and weighed to the nearest 0.01 pound. These samples were then dried in forced air ovens and the dry weight obtained for percent moisture calculation for each sample.

In 1976 plots were cut with a sickle mower. Yield samples were taken by dropping a square wooden frame with an inside area of 5 square feet and taking the grass within this frame. Three such samples were taken per plot to make a 15 square foot yield sample. These yield samples were treated as previously described.

After these samples had been properly dried and weighed for moisture analysis, a 100 gram sub-sample was prepared (Nelson 1974) for in vitro quality determinations. Quality measurements taken for each grass sample included an analysis of cell wall constituents (CWC), acid detergent fiber (ADF), cellulose, and acid insoluble lignin according to Foering and Van Soest (1970). Hemicellulose was calculated as the difference between cell wall constituents and acid detergent fiber. In vitro digestible dry matter (IVDDM) values were determined by a modified Van Soest procedure (Nelson et al., 1973). Percent protein was measured in 1976 only.

Leafhopper-planthopper populations were sampled with a standard 15-inch sweep net by taking 15 sweeps diagonally across each plot each week of the study period. Samples were transported to the laboratory in plastic bags for sorting and identification. Data collected from all test sites were pooled and analyzed by Harvey's least squares analysis of variance as contained within the Statistical Analysis System (Barr 1977).

The effect of leafhopper-planthopper populations on yield at different periods of the growing season was studied in 1973-74. Data from harvest treatments 1, 2, and 3 were divided into 3 growth periods. Growth period 1 (early-season) included June and July, growth period 2 (mid-season) included August and September, and growth period 3 (late-season) included October and November. Yield losses caused by hoppers during each growth period was determined by comparing (1) the average number of hoppers/sweep to average yield and (2) the difference in number of hoppers/sweep to the difference in yield between treated and untreated grass.

RESULTS AND DISCUSSION: A large majority of the leafhopper-planthopper population consisted of 4 species. The planthopper, Delphacodes propinqua (Fieber), averaged 49.3% of the composite population during 1974. The leafhoppers Exitianus exitiosus (Uhler), Graminella nigrifrons (Forbes), and Draeculacephala portola (Ball), composed 18.4%, 15.1% and 5.2% of the population, respectively during 1974. The seasonal distribution of the composite leafhopper-planthopper population throughout the study period is illustrated in Figure 1. The large increase in population numbers in late September and October is due primarily to an increase in the number of Delphacodes propinqua. Other potentially damaging insects such as grasshoppers, spittle bugs, army-worms, or mirids were present in low numbers, but were deemed insignificant throughout the study period.

A highly significant difference existed in numbers of leafhoppers-planthoppers between insecticide treated and untreated plots (Table 1, 2). Population counts ranged from zero per sweep in treated plots to 898 per sweep in untreated plots. Leafhopper-planthopper populations for the entire study averaged 4.8/sweep on treated grass and 22.8/sweep on untreated grass.

There was also a highly significant difference in numbers of leafhoppers-planthoppers/sweep among harvesting treatments (Table 2, 3). Leafhopper-planthopper populations were significantly smaller in harvest treatments 1 and 2 (simulated close grazing and cut at 6 inches respectively) than in the 3 less frequently harvested treatments. Leafhopper-planthopper numbers were also significantly smaller in grass harvested 3 times a year than in grass harvested one time at the end of the growing season. Although the relationship of harvest frequency to leafhopper-planthopper numbers was not strictly linear, it was apparent that as the harvest frequency of the grass increased, a general decrease in leafhopper-planthopper numbers occurred.

The overall average increase in yield for all harvest treatments was 0.96 tons of dry forage per acre or a 17.9% increase attributable to leafhopper-planthopper control (Table 4). This represented a highly significant increase in yield of insecticide-treated over untreated grass (Table 1). However, yield increases varied according to harvest frequency. Yield increases as a result of leafhopper-planthopper control ranged from 3.6% in the simulated close grazing treatment to 49.3% in the one cutting per year grass. This general trend indicated that as harvest frequency decreased, a greater increase in yield, attributable to insect control, occurred. Thus the least frequently harvested grass had substantially greater reductions in yield attributable to insect damage than grass that was harvested more frequently.

A comparison of the size of the leafhopper-planthopper populations with the yield for early, mid, and late-season grass showed that the largest leafhopper-planthopper populations and the lowest yields occurred in late season during October and November (Table 5), while the smallest leafhopper-planthopper populations and the largest yield occurred in mid-season during August and September. However, comparison of differences in leafhopper-planthopper infestations and yields between insecticide-treated and untreated grass shows that the largest difference in yield (.82 tons dry matter/acre) or the largest reduction in yield due to these insects occurred in early season (June-July). Although leafhopper-planthopper infestations were larger and yield smaller in late season than in early and mid-season, less yield reduction attributable to these insects occurred at this time. Therefore, the greatest yield reductions caused by the leafhopper-planthopper complex appears to occur in June and July even though the largest leafhopper-planthopper populations generally occur in October and November.

A significant difference also existed in percent moisture of insecticide-treated vs untreated grass (Table 1, 6) with treated grass having an average increase in moisture of 3.0% over untreated grass. Grass plots having the largest infestations of leafhoppers-planthoppers (1 cutting per year) had the greatest reduction in percent moisture due to the feeding of these insects (Table 6).

No significant difference existed between insecticide-treated and untreated grass in digestible dry matter content or any of the chemical constituents measured for grass quality determination except for cellulose content which was significantly higher in treated grass (Table 1).

CONCLUSIONS: By controlling leafhopper-planthopper populations in Coastal bermudagrass with insecticide, increases in yield of 3.6% to 49.3% may be realized under Louisiana conditions, depending upon frequency of harvest. At $1.75/60 pound bale of hay, this would represent a monetary loss attributable to the leafhopper-planthopper complex ranging from $11.02 to $138.25 per acre. Although the largest leafhopper-planthopper populations occur late in the growing season (October-November) the greatest yield reduction due to these insects appears to occur during the early part of the season (June-July).

Since increasing harvest frequency significantly reduced leafhopper-planthopper populations, increasing harvest frequency of hay pastures to at least 3 to 4 times per growing season will offer some relief from these pests and may also serve effectively as one component in a pest management system for their control. The fact that leafhoppers and planthoppers had little effect on the digestible dry matter and most other chemical parameters measured for quality determination of Coastal bermudagrass, indicated that their detrimental effect is reflected primarily in yield reduction rather than in reduced grass quality.

Table 1. Comparison of means of leafhopper-planthopper populations, yield and parameters measured for grass quality determination in insecticide treated and untreated Coastal bermudagrass in Louisiana[1].

Chemical treatment	Hoppers/sweep	Yield (tons dm/ac)	% H_2O	% CWC
1 (treated)	4.82	6.35	54.8	72.2
2 (untreated)	22.82**	5.38**	51.6*	72.5
Chemical treatment	**% Hemicellulose**	**% ADF**	**% Cellulose**	**% Lignin**
1 (treated)	36.8	35.3	27.1	5.9
2 (untreated)	37.4	35.0	26.7*	5.9
Chemical treatment	**% Ash**	**% IVDDM**	**% Protein[2]**	
1 (treated)	2.2	50.4	9.4	
2 (untreated)	2.3	50.6	9.3	

[1]Composite of data collected at Winnsboro (1973-74), Clinton (1974, 1976), and Bossier City (1976).

[2]Protein measured only at Bossier City and Clinton - 1976.

Table 2. Average number of leafhoppers-planthoppers/sweep in insecticide treated and untreated Coastal bermudagrass harvested at various frequencies in Louisiana[1].

	Harvest treatment					
Insecticide treatment	1 simulated (close grazing)	2 (Cut at 6")	3 (3 cuttings/yr)	4 (2 cuttings/yr)	5 (1 cutting/yr)	Overall avg.
Treated	2.8	2.8	5.7	6.1	6.7	4.8
Untreated	15.6	14.1	22.5	26.1	35.7	22.8**
Difference	12.8	11.4	16.9	20.0	29.0	18.0

[1] Composite of data collected at Winnsboro (1973-74), Clinton (1974, 1976), and Bossier City (1976).

Table 3. Average number of leafhoppers-planthoppers/sweep for each of five harvesting frequencies in Coastal bermudagrass in Louisiana[1].

Harvesting treatment	Hoppers/sweep	Q Statistic[2]
1 (simulated close grazing)	11.2	6.1
2 (cut at 6 inches)	10.8	
3 (3 cuttings/year)	34.5	
4 (2 cuttings/year)	39.4	
5 (1 cutting/year)	43.0	

[1]Composite of data collected at Winnsboro (1973-74), Clinton (1974, 1976), and Bossier City (1976).

[2]Calculated according to Tukey's test of significance.

Table 4. Average yield of Coastal bermudagrass (tons dry forage/acre) harvested at various frequencies in insecticide treated and untreated plots in Louisiana[1].

	Harvest treatment					
	1	2	3	4	5	
Insecticide treatment	simulated (close grazing)	(Cut at 6")	(3 cuttings/yr)	(2 cuttings/yr)	(1 cutting/yr)	Overall avg.
Treated	5.42	5.87	5.71	7.60	7.17	6.35
Untreated	5.23	5.52	5.25	6.14	4.80	5.39**
Difference	.19	.35	.46	1.46	2.37	.96
% increase yield in treated plots	3.63	9.04	8.76	23.70	49.30	17.92

[1]Composite of data collected at Winnsboro (1973-74), Clinton (1974, 1976), and Bossier City (1976).

Table 5. Seasonal effect of leafhopper-planthopper populations on yield of Coastal bermudagrass in each of 3 growth periods in Louisiana[1].

Growth period	Avg. no. hoppers/sweep and avg. yield of treated and untreated plots combined: Hoppers/sweep	Avg. no. hoppers/sweep and avg. yield of treated and untreated plots combined: Yield (lbs/100 sq. ft.)	Difference in hoppers/sweep and yield between treated and untreated plots: Hoppers/sweep	Difference in hoppers/sweep and yield between treated and untreated plots: Yield (tons dm/ac)
1 (June-July)	7.6	4.77	10.4	.82
2 (August-September)	5.3	6.35	7.3	.76
3 (October-November)	21.0	3.31	29.5	.23

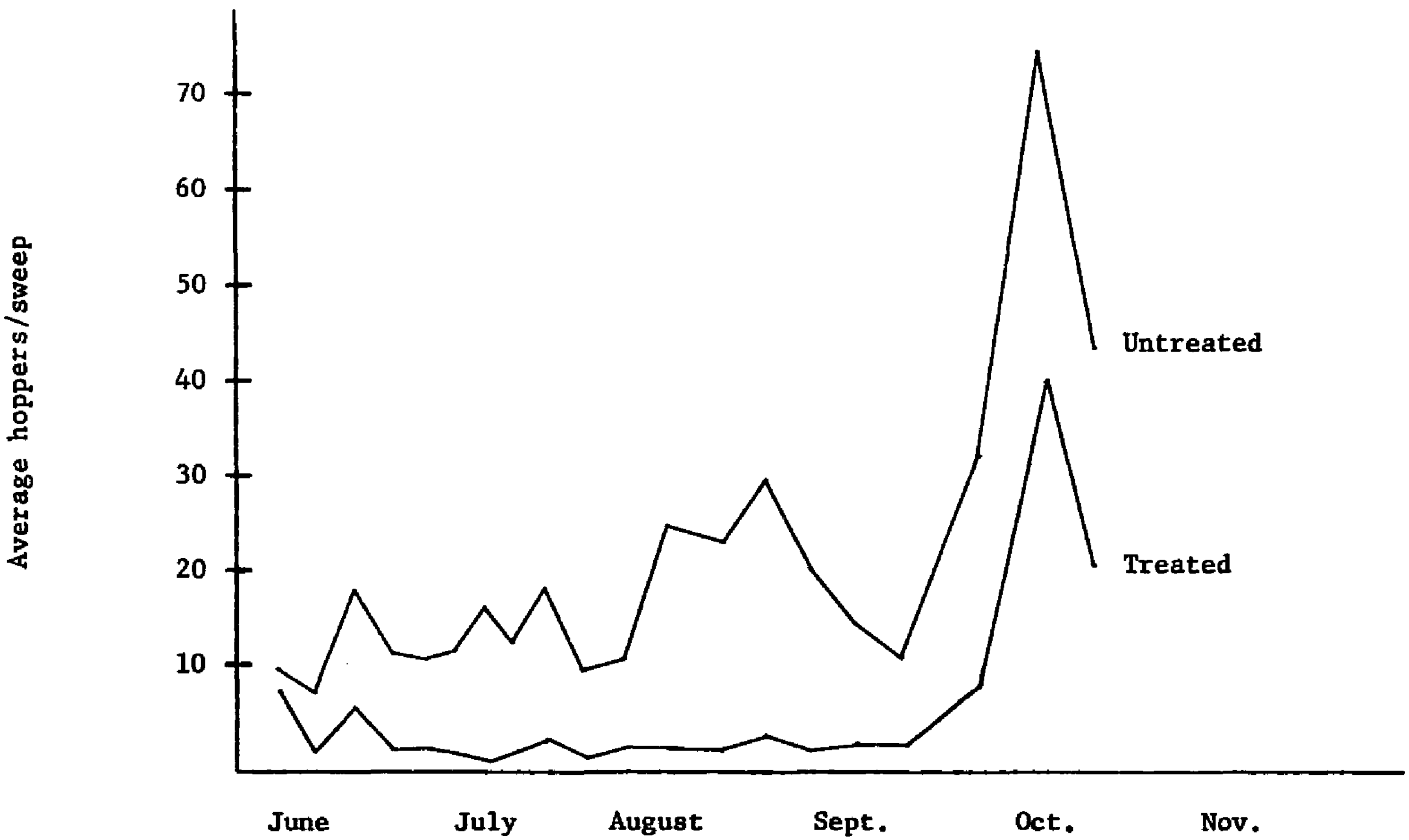
*Composite of data collected at Winnsboro (1973-74) and Clinton (1974).

Table 6. Average percent moisture of Coastal bermudagrass in insecticide treated and untreated plots harvested at various frequencies in Louisiana[1].

	Harvest treatment					
Insecticide treatment	1 simulated (close grazing)	2 (Cut at 6")	3 (3 cuttings/yr)	4 (2 cuttings/yr)	5 (1 cutting/yr)	Overall avg.
Treated	59.0	59.0	53.0	54.0	50.0	54.8
Untreated	58.0	57.0	53.0	52.0	42.0	51.6*
Difference	1.0	2.0	0.0	2.0	8.0	3.2

[1]Composite of data collected at Winnsboro (1973-74), Clinton (1974, 1976), and Bossier City (1976).

Figure 1. Seasonal distribution of leafhopper-planthopper populations in treated and untreated plots presented as a composite of data collected at Winnsboro, Louisiana 1973-74; Clinton, Louisiana 1974, 1976; and Bossier City, Louisiana 1976.



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APPENDIX

Table 1. Total yield of coastal bermudagrass in pounds dry matter per 100 square feet for each of 5 harvesting treatments comparing treated and untreated plots at Winnsboro, Louisiana 1973-74; Clinton, Louisiana 1974, 1976; and Bossier City, Louisiana 1976.

	Site	Yr.	Rep.	Simulating close grazing	Cut at 6"	3 cuttings	2 cuttings	1 cutting
Treated	Winnsboro	'73	1	29.71	42.27	31.83	38.06	27.79
		'74	1	10.22	15.17	15.80	11.74	17.44
		'74	2	9.24	10.23	14.73	9.41	13.05
	Clinton	'74	1	22.26	18.08	30.31	30.49	23.31
		'74	2	23.70	21.95	30.78	34.33	27.73
		'74	3	22.53	23.76	30.65	35.12	27.15
		'76	1	26.80	27.00	29.00	34.70	26.00
	Bossier City	'76	1	25.40	32.10	24.00	43.50	50.00
			Total	169.86	190.56	207.10	237.35	212.47
Untreated	Winnsboro	'73	1	26.57	26.65	33.59	33.58	21.08
		'74	1	13.08	10.40	14.87	12.69	19.13
		'74	2	9.11	9.69	9.71	7.91	9.98
	Clinton	'74	1	16.48	18.40	28.16	30.91	16.07
		'74	2	16.98	20.57	25.48	24.63	19.90
		'74	3	17.66	21.04	26.25	28.84	16.73
		'76	1	26.10	23.70	25.30	24.00	14.00
	Bossier City	'76	1	27.30	31.30	24.00	37.50	35.00
			Total	153.27	161.74	187.35	200.06	151.89

Table 2. Average number of leafhoppers-planthoppers/sweep in coastal bermudagrass comparing treated and untreated plots for each of 5 harvesting treatments at Winnsboro, Louisiana 1973-74; Clinton, Louisiana 1974, 1976; and Bossier City, Louisiana 1976.

	Site	Yr.	Rep.	Simulating close grazing	Cut at 6"	3 cuttings	2 cuttings	1 cutting
Treated	Winnsboro	'73	1	11.10	9.30	30.70	33.20	35.00
		'74	1	1.09	.90	1.47	1.10	1.52
		'74	2	1.89	1.40	1.29	1.33	1.21
	Clinton	'74	1	1.10	2.29	1.34	1.25	2.99
		'74	2	1.31	1.07	1.60	1.40	2.49
		'74	3	1.13	1.50	.90	3.02	2.27
		'76	1	1.84	2.88	1.99	1.69	1.69
	Bossier City	'76	1	1.34	1.61	1.66	1.17	1.94
			Total	2.8	2.8	5.7	6.1	6.7
Untreated	Winnsboro	'73	1	30.90	27.60	89.20	90.80	88.60
		'74	1	7.46	2.98	5.29	7.03	8.19
		'74	2	7.61	4.54	6.27	6.21	5.66
	Clinton	'74	1	12.06	16.57	20.25	22.71	32.13
		'74	2	16.33	17.21	15.06	26.31	50.52
		'74	3	11.27	15.02	9.53	22.58	11.03
		'76	1	14.85	10.59	7.54	8.58	9.13
	Bossier City	'76	1	20.41	17.06	16.40	16.97	68.62
			Avg.	15.6	14.1	22.5	26.1	35.7

Table 3. Average percent moisture of coastal bermudagrass comparing treated and untreated plots for each of 5 harvesting treatments from Winnsboro, Louisiana 1973-74; Clinton, Louisiana 1974, 1976; and Bossier City, Louisiana 1976.

	Site	Yr.	Rep.	Simulating close grazing	Cut at 6"	3 cuttings	2 cuttings	1 cutting
Treated	Winnsboro	'73	1	58	62	58	45	52
		'74	1	53	54	47	54	51
		'74	2	55	56	47	53	48
	Clinton	'74	1	54	58	49	58	53
		'74	2	59	60	49	59	51
		'74	3	60	62	59	57	51
		'76	1	68	60	51	54	46
	Bossier City	'76	1	67	59	56	54	50
			Avg.	59	59	53	54	50
Untreated	Winnsboro	'73	1	51	58	53	53	60
		'74	1	54	49	50	51	47
		'74	2	54	52	51	54	48
	Clinton	'74	1	57	57	55	47	42
		'74	2	59	57	53	52	38
		'74	3	57	58	54	56	32
		'76	1	65	61	50	50	30
	Bossier City	'76	1	63	55	52	51	42
			Avg.	58	57	53	52	42

Table 4. Chemical analysis of coastal bermudagrass samples showing average data for treated and untreated plots for each of 5 harvesting treatments at Winnsboro, Louisiana and Clinton, Louisiana 1974.

	Harvesting treatment	CWC	Hemicellulose	ADF	Cellulose	Acid insol. lignin	Acid insol. ash	in Vitro DDM
Treated	Simulating close grazing	70.9	37.1	33.8	26.3	5.14	2.65	50.5
	Cut at 6"	70.6	37.3	33.3	26.1	5.20	2.08	51.5
	3 cuttings	71.2	37.3	34.0	25.9	5.50	2.76	50.6
	2 cuttings	73.5	37.9	35.7	27.7	6.39	1.89	49.8
	1 cutting	73.6	35.5	38.0	27.6	6.30	1.98	48.2
	Avg.	71.2	37.1	34.08	26.36	5.38	2.40	50.6
Untreated	Simulating close grazing	67.6	35.2	32.4	24.5	5.27	2.72	51.8
	Cut at 6"	70.8	37.4	33.4	26.1	5.07	2.30	52.6
	3 cuttings	70.2	37.0	33.2	25.8	5.09	2.42	49.4
	2 cuttings	73.0	37.7	35.2	26.5	6.06	2.65	51.5
	1 cutting	73.7	37.5	36.2	27.1	6.99	2.27	47.5
	Avg.	70.7	37.0	33.73	25.84	5.41	2.54	51.34

Table 5. Chemical analysis of coastal bermudagrass samples showing average data for treated vs untreated plots for each of 5 harvesting treatments at Clinton, Louisiana and Bossier City, Louisiana 1976.

	Harvesting treatment	CWC	Hemicellulose	ADF	Cellulose	Acid insol. lignin	Acid insol. ash	in Vitro DDM
Treated	Simulating close grazing	71.8	37.3	34.5	26.2	5.95	2.07	55.2
	Cut at 6"	71.9	37.7	34.2	26.8	5.64	2.04	55.4
	3 cuttings	72.0	35.9	36.1	27.8	6.15	2.23	52.6
	2 cuttings	75.1	37.8	37.3	30.5	7.16	2.33	49.7
	1 cutting	73.4	33.7	39.7	30.0	7.55	2.30	44.5
	Avg.	72.8	36.5	36.4	28.3	6.49	2.19	51.5
Untreated	Simulating close grazing	73.4	37.8	35.7	27.2	6.26	2.05	54.2
	Cut at 6"	74.0	38.5	35.5	27.5	5.92	2.07	54.4
	3 cuttings	75.5	37.3	38.2	29.7	7.03	2.01	52.7
	2 cuttings	75.8	38.5	37.3	28.4	6.76	2.46	48.0
	1 cutting	74.7	36.9	37.8	28.7	6.75	2.35	46.2
	Avg.	74.7	37.8	36.9	28.3	6.54	2.19	51.1

Table 6. Average percent moisture of Coastal bermudagrass for each of 5 harvesting treatments in Louisiana[1].

Harvesting treatment	Percent moisture	Q Statistic[2]
1 (simulated close grazing)	57.5	4.8
2 (cut at 6 inches)	57.2	
3 (3 cuttings/year)	52.6	
4 (2 cuttings/year)	52.7	
5 (1 cutting/year)	46.3	

[1]Composite of data collected at Winnsboro (1973-74), Clinton (1974, 1976), and Bossier City (1976).

[2]Calculated according to Tukey's test of significance.

Figure 1. A schematic illustration of one complete replication of the split-plot randomized block design utilized at Winnsboro, Louisiana 1973-74; Clinton, Louisiana 1974, 1976; and Bossier City, Louisiana 1976.

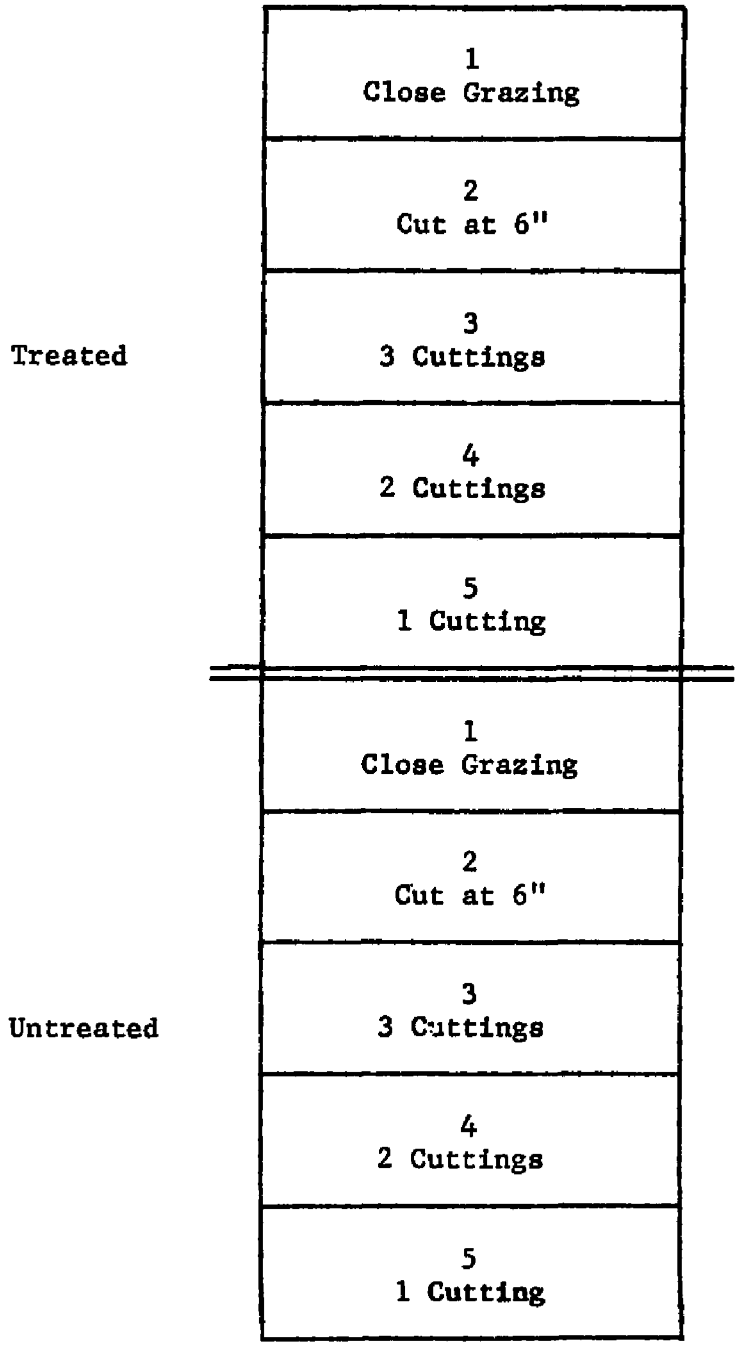


Figure 2. Seasonal distribution of the composite leafhopper-planthopper population showing average hoppers/sweep in treated and untreated plots at Winnsboro, Louisiana 1973.

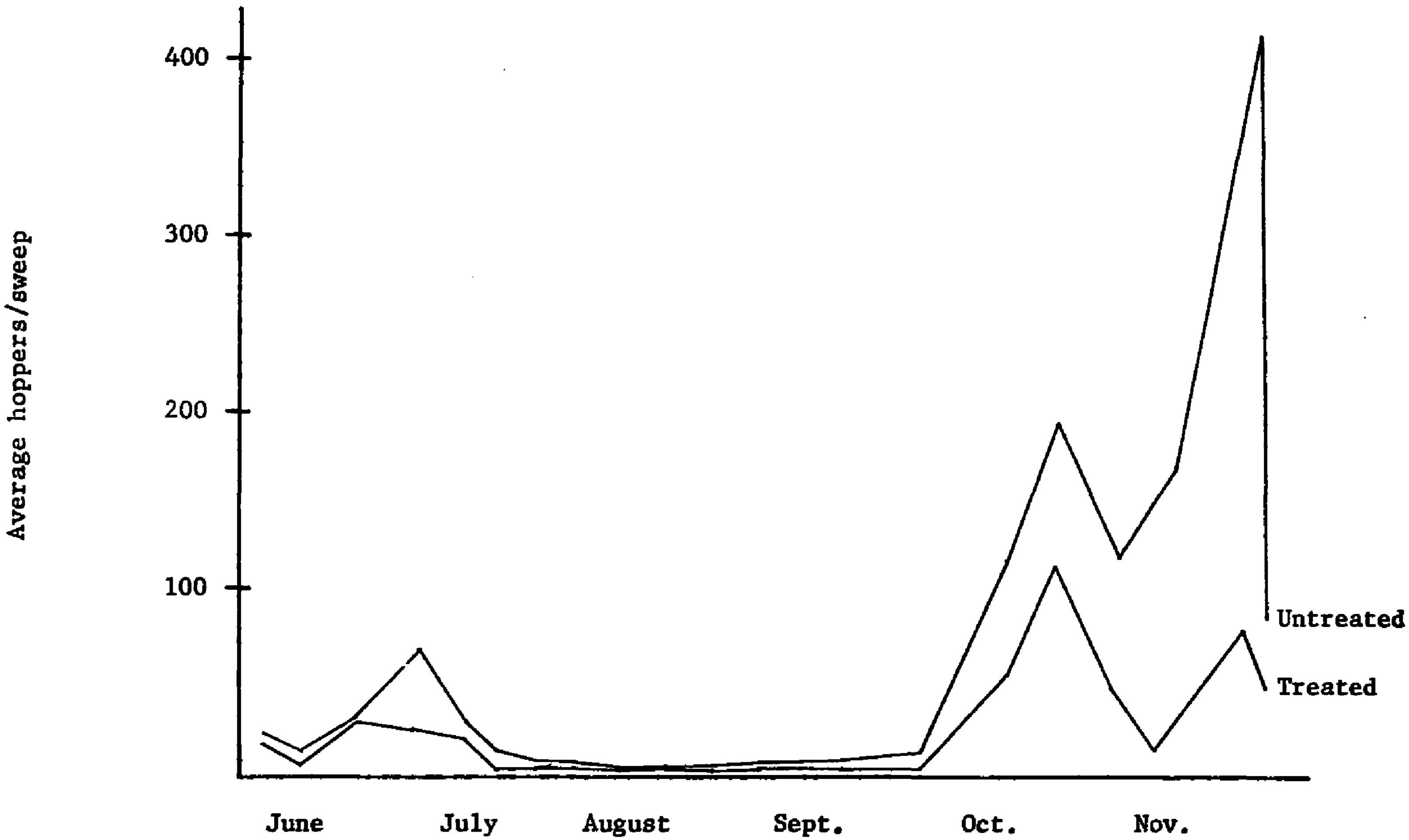


Figure 3. Seasonal distribution of the composite leafhopper-planthopper population showing average hoppers/sweep in treated and untreated plots at Winnsboro, Louisiana 1974.

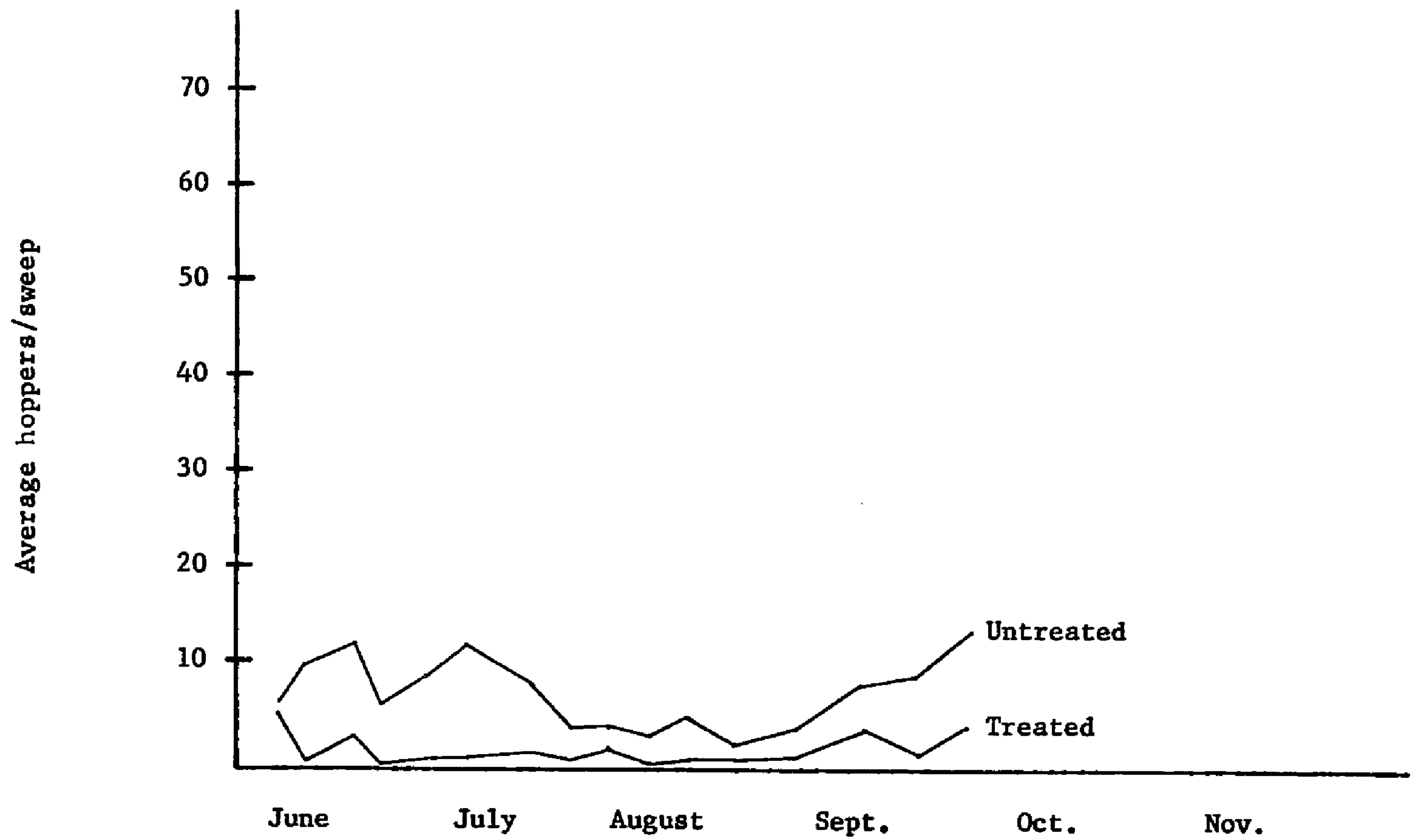


Figure 4. Seasonal distribution of the composite leafhopper-planthopper population showing average hoppers/sweep in treated and untreated plots at Clinton, Louisiana 1974.

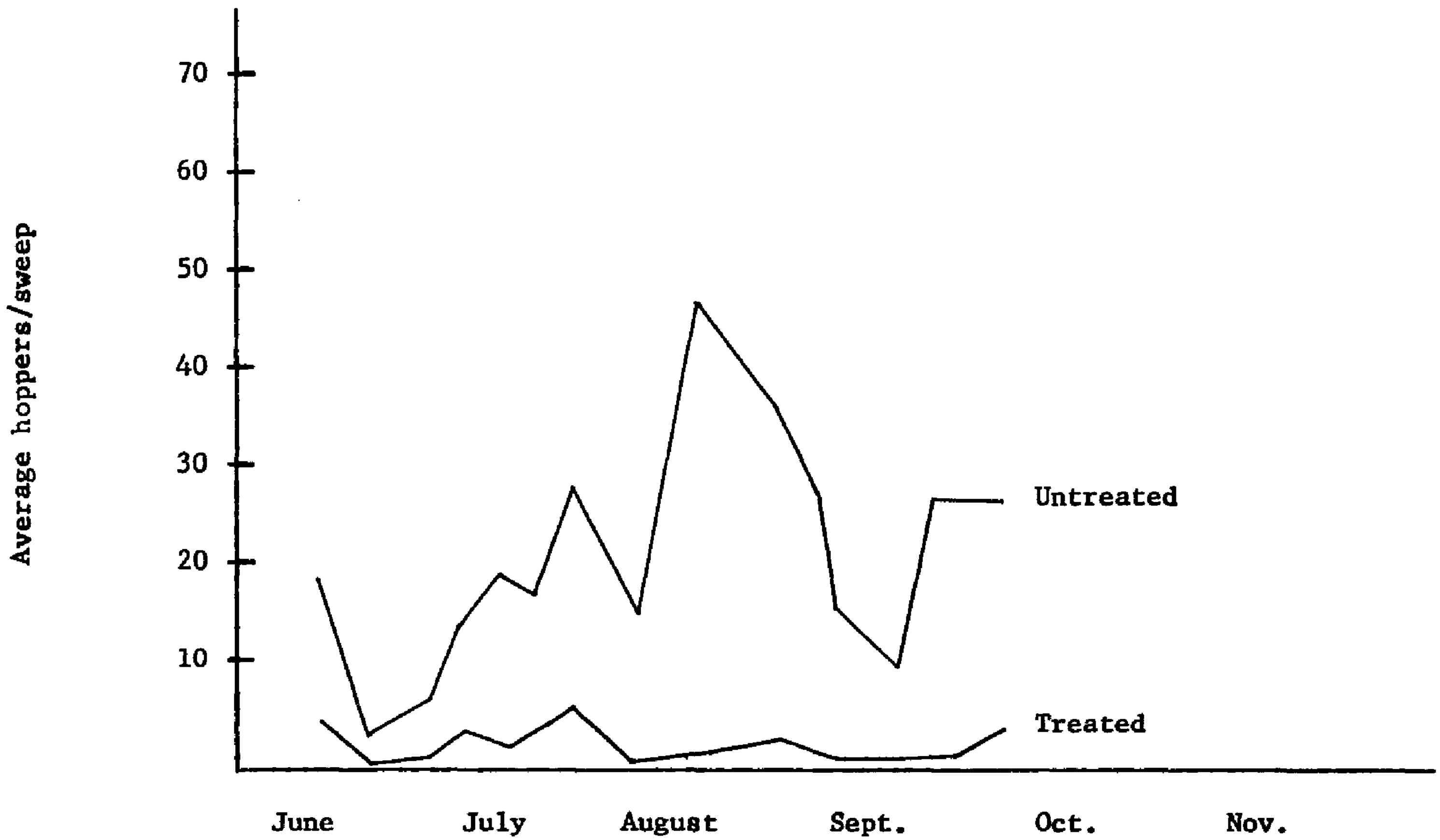


Figure 5. Seasonal distribution of the composite leafhopper-planthopper population showing average hoppers/sweep in treated and untreated plots at Clinton, Louisiana 1976.

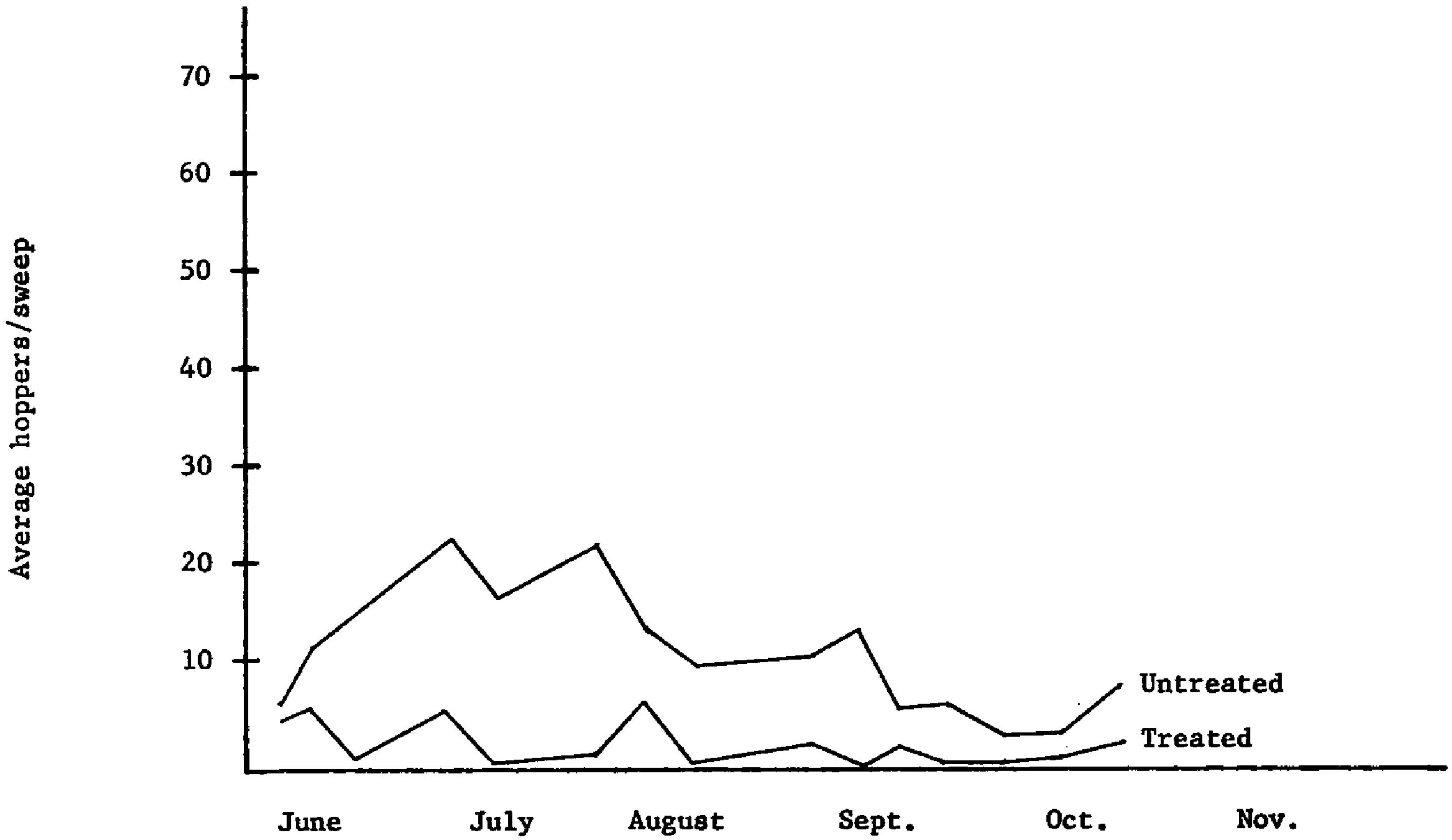


Figure 6. Seasonal distribution of the composite leafhopper-planthopper population showing average hoppers/sweep in treated and untreated plots at Bossier City, Louisiana 1976.

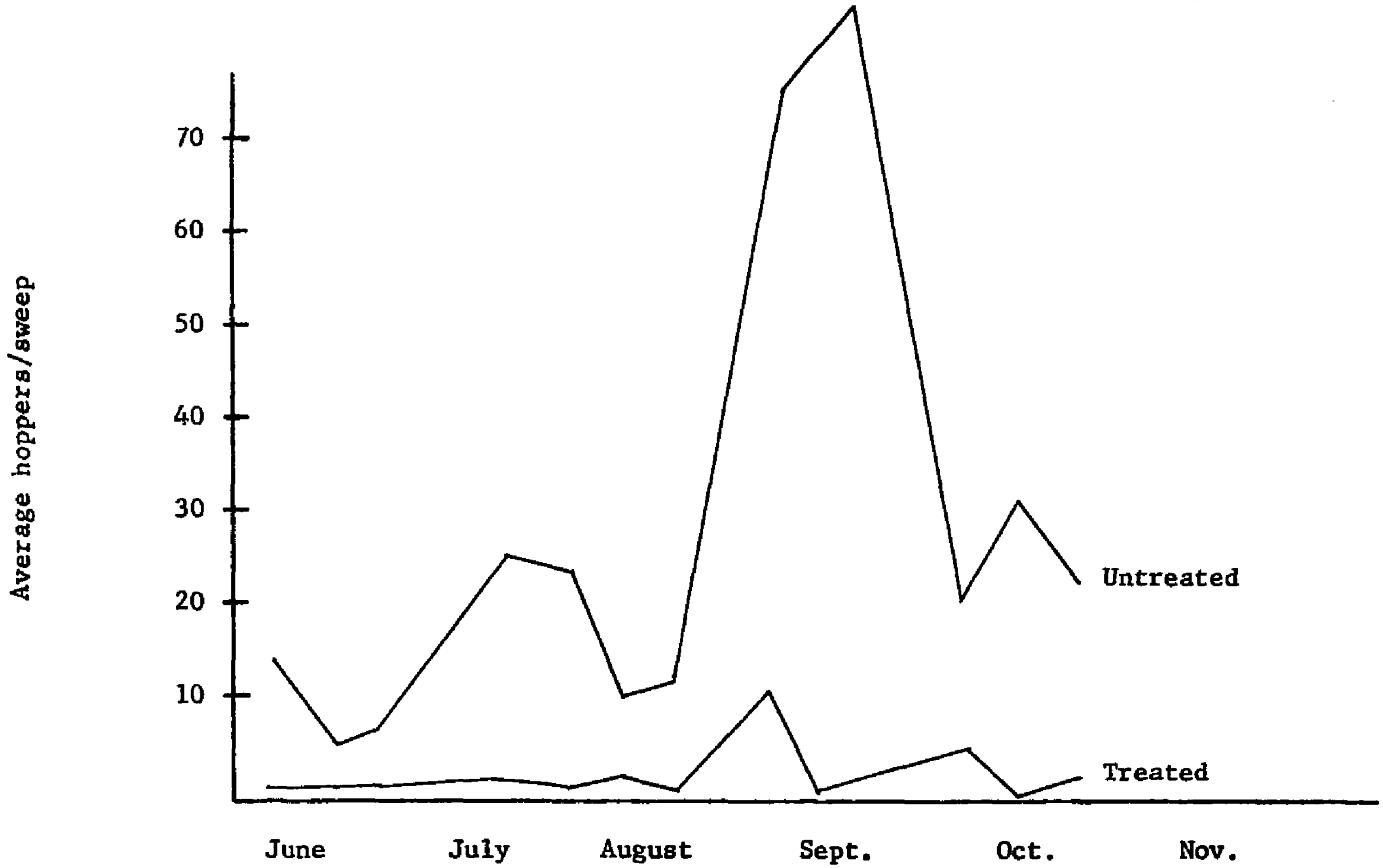


Figure 7. Species composition of the leafhopper-planthopper population at Winnsboro, Louisiana 1974, shown as per cent of the total population of the two most prevalent species.

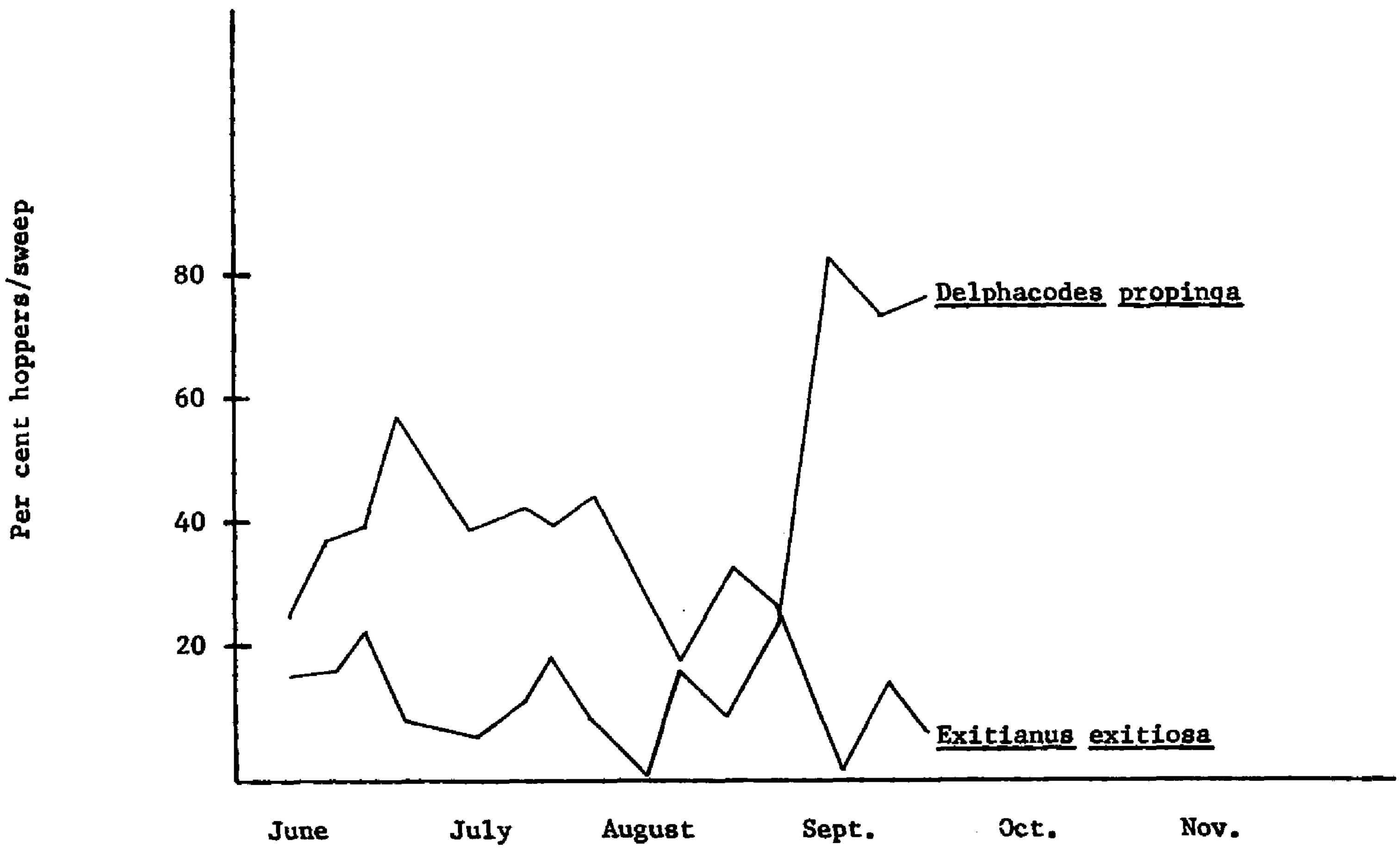


Figure 8. Species composition of the leafhopper-planthopper population at Winnsboro, Louisiana 1974, shown as per cent of the total population of the third and fourth most prevalent species.

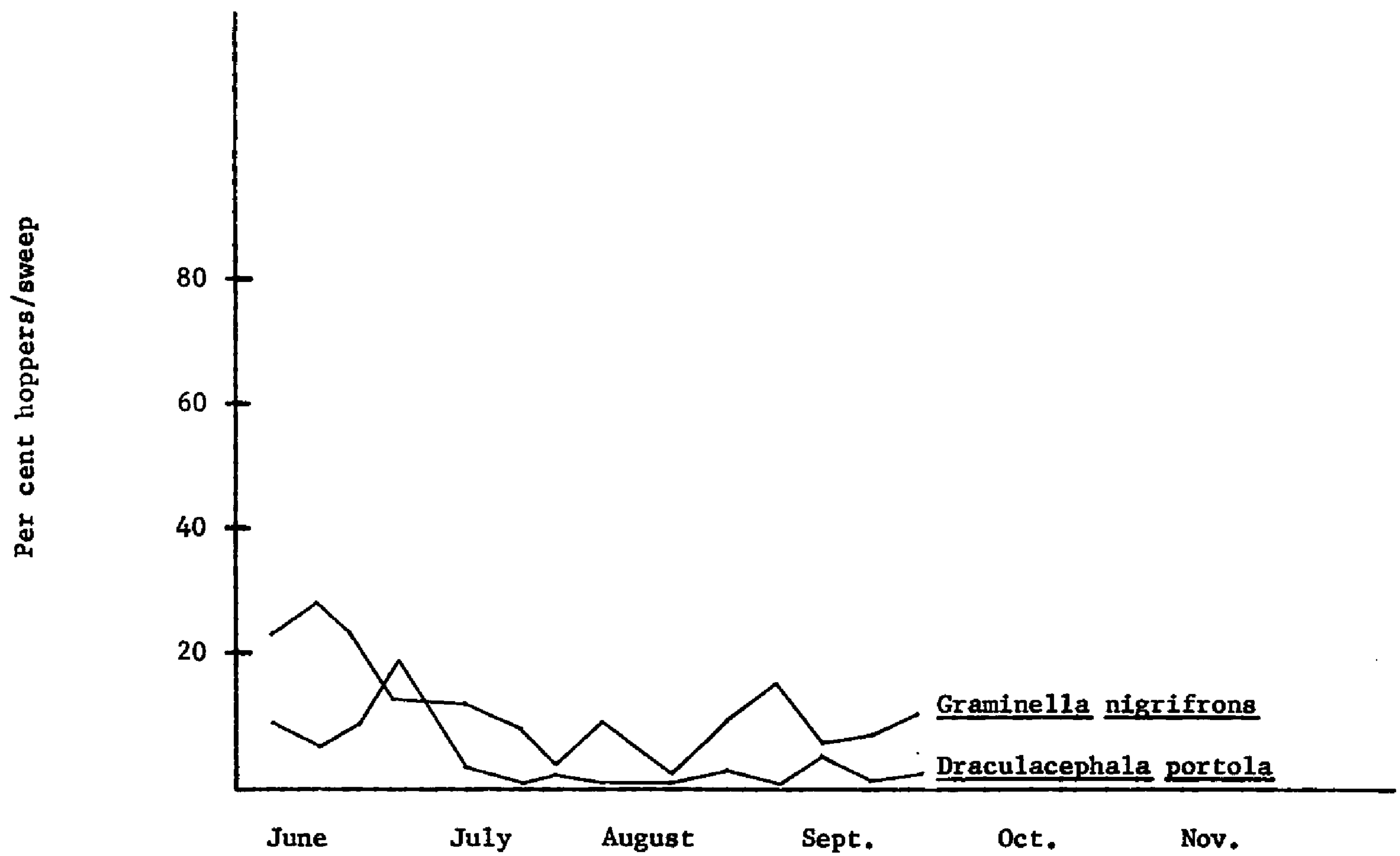
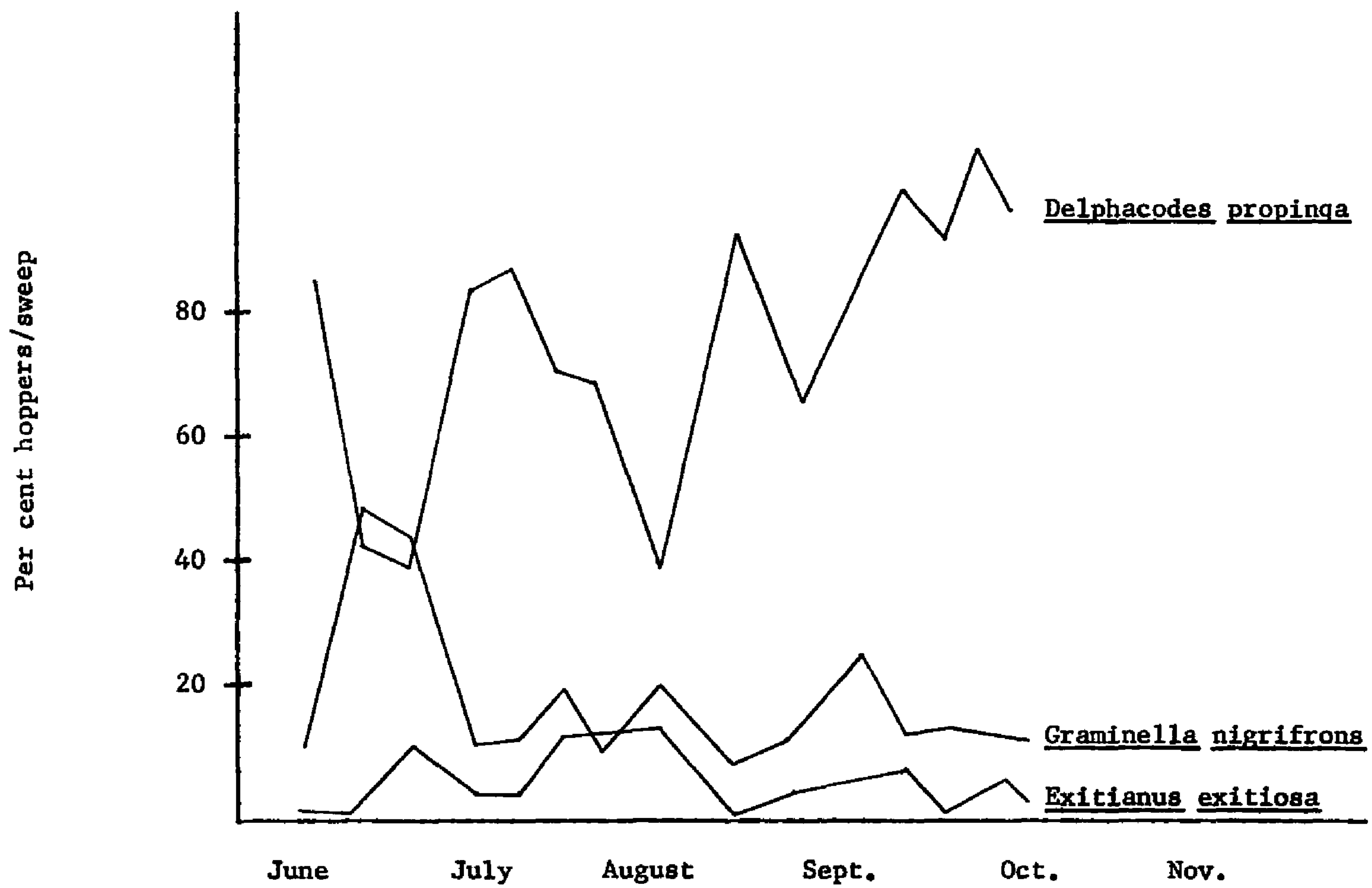


Figure 9. Species composition of leafhopper-planthopper population at Clinton, Louisiana 1974, shown as per cent of the total population for the three most prevalent species.



VITA

James Alan Hawkins was born to Harold Leighton Hawkins and Margaret Johnson Hawkins October 14, 1949, at Rockymount, North Carolina. He attended Bolton High School at Alexandria, Louisiana, and graduated from there in 1967.

Hawkins attended Louisiana State University - Alexandria from September 1967 until December 1968. He then transferred to the main campus of Louisiana State University at Baton Rouge, Louisiana from which he received a Bachelor of Science degree in Forest Management in May 1971, a Master of Science in Entomology in May 1973, and a Doctor of Veterinary Medicine degree in May 1978. He is presently a candidate for the degree of Doctor of Philosophy in Entomology.

EXAMINATION AND THESIS REPORT

Candidate: James Alan Hawkins

Major Field: Entomology

Title of Thesis: Leafhoppers and Planthoppers Infesting Coastal Bermudagrass: Their Effect on Yield and Quality; Their Control by Varying Frequency of Harvest

Approved:

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Major Professor and Chairman

Carolyn H. Hargrave

Dean of the Graduate School

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Date of Examination:

July 17, 1978